School of Chemical Engineering

UNSW Engineering

CEIC8341

Membrane Processes

Term 3, 2022

Course Overview

Staff Contact Details

Convenors

Name	Email	Availability	Location	Phone
Pierre Le-Clech	p.le-clech@unsw.edu.au	by appointment	521 (Hilmer building, entry through SEB)	

School Contact Information

For assistance with enrolment, class registration, progression checks and other administrative matters, please see the Nucleus: Student Hub. They are located inside the Library – first right as you enter the main library entrance. You can also contact them via http://unsw.to/webforms or reserve a place in the face-to-face queue using the UniVerse app.

If circumstances outside your control impact on submitting assessments, Special Consideration may be granted, usually in the form of an extension or a supplementary assessment. Applications for Special Consideration must be submitted online.

For course administration matters, please contact the Course Coordinator.

Course Details

Units of Credit 6

Summary of the Course

This course provides a comprehensive introduction to the membrane technology and its applications in the industry. The various membrane materials, structures, configurations, modules and processes will be discussed in details along with some of the governing equations for use in the system design. Advantages and limitations of this technology will be presented and discussed in class through tutorial and seminar given membrane experts from the UNESCO Centre for Membrane Science and Technology. The optimisation of the membrane operation in terms of hydraulic and removal performances will also be argued. Moreover, many of the industrial process applications in which membrane find employment, such as water, wastewater, biotechnology, gas and food industries will be discussed.

Course Aims

The current need for cleaner and more efficient treatment processes has significantly helped the development of membrane technology in industrial applications. Background knowledge in this type of process will certainly increase the chance of the enrolled students to obtain a position in environmental companies dealing with air/gas or water/wastewater treatments. Since membranes could also be applied in the water/wastewater, pharmaceutical, medical and food industries, career prospects for students may be increased.

Course Learning Outcomes

After successfully completing this course, you should be able to:

Learning Outcome	EA Stage 1 Competencies
1. Describe and justifty membrane technology selection in a wide range of industrial and domestic applications.	PE2.2
2. Define and select the appropriate membrane characteristics, configurations, operating conditions.	PE1.3
3. Evaluate the suitability of membrane systems for a given application and provide design advice on the advantages and limitations of available options.	PE2.1
4. Analyse mass transfer in membrane processes and to use both theoretical and semi-empirical methods in design contexts.	PE1.1

On completion of this course, you should be able to have a very acute understanding of the use of the membrane technology in a wide range of industrial applications. You should be able to define the different membrane characteristics, configurations, operating conditions. You would also have a better understanding of the advantages and limitations of membrane systems (compared to other comparable technologies) for a given application and would be able to advice a third party of the option of choice. Finally, you also should be able to use basic theoretical equations and correlations to define the mass transfer occurring in such processes. You will have the opportunity to demonstrate those outcomes in

the assignment and the exam paper, during which your critical mind will be used on your new knowledge. Each of the intended outcomes is classified according to the UNSW graduate capabilities scheme and according to elements of the Engineers Australia stage 1 competencies.

Teaching Strategies

2x2-hour-classes will be held on the dates shown in the schedule. Emphasis will be given to lectures including questions for the students to reflect their learning. At the end of most lectures, opportunity will be given for the students to ask further question about the lectures and to seek assistance towards self-study questions and/or group assignment. This will encourage interactions with the class. This time will also be used for discussing more general issues (costs, environmental impacts, …) related to membrane processes. Visit and demonstration in the labs of the Membrane Centre will be used as a practical approach to better understand membrane processes.

In keeping with the principles of adult learning, it is expected that some of the time allocated to this course will be spent in self-directed learning. Hence, the heavy emphasis will be given to the assessment on your own assignment and self-directed reading. The list of self-study questions should be used as a guideline to direct your private reading and your understanding of the seminars over the session. The list is not exhaustive but is indicative of the range of principles that you should be able to describe in general terms by the end of the course and of the types of questions that may be on the examination.

Effective learning is supported when students are actively engaged in the learning process:

- Active participation will be requested from students during seminars, tutorials and lab demonstration.
- It is also expected that students will work on the self-study questions before tutorial time.

Structured occasions for reflection allow students to explore their experiences, challenge current beliefs, and develop new practices and understandings:

- This will be possible during tutorial times and group project, where learning cooperatively with peers - rather than in an individualistic or competitive way - may help students to develop interpersonal, professional, and cognitive skills to a higher level.
- When students are encouraged to take responsibility for their own learning, they are more likely to develop higher-order thinking skills such as analysis, synthesis, and evaluation.

Clearly articulated expectations, goals, learning outcomes, and course requirements increase student motivation and improve learning

- Time will be devoted to explain the course outlines in Week 1.
- Meaningful and timely feedback will be provided to students after quizzes and group project on weeks 4, 5, and 11.

Additional Course Information

Prerequisite knowledge and relationships to other courses:

There is no prerequisite for this course. However, general knowledge on separation processes (already given in CEIC3004) will be useful to assess the advantages and limitations of membrane technology for a given application. The advanced particle and separations course (CEIC8103) is relevant to this

subject. Alternatively, introductory text could be found in some of the references given at the end of this document. Some emphasis will be put on the use of membrane for water and wastewater treatments and courses like CVEN9857 and 9851 will reiterate and develop some of the materials given in that course.

Expected time engagement for this course:

Period	**Online lectures**	**Self-directed study and homework**	**Online quizzes (+ assignment)**	**Final Exam**	**Total hours**
Week 1	4	2			**6**
Week 2	4	4	1		**9**
Week 3	4	4			**8**
Week 4	4	4	2		**10**
Week 5	4	4	2(+3)		**13**
Week 6	(2)	4	(+3)		**9**
Week 7	4	4	3(+3)		**14**
Week 8	4	4	(+3)		**11**
Week 9	4	4	2(+3)		**13**
Week 10	4	4	3(+3)		**14**
Exam period				13	**13**
Total hours	38	38	13(+18)	13	**120**

Assessment

Assessment task	Weight	Due Date	Course Learning Outcomes Assessed
1. Online Quizzes	20%	Throughout the term (weeks 2, 4, 7 and 10)	1, 2
2. Mid-Term Quiz	20%	14/10/22 by 9pm	1, 2, 3, 4
3. Assignment	30%	05/11/2021 09:00 PM	1, 2, 3, 4
4. Final Exam	30%	Exam period	1, 2, 3, 4

Assessment 1: Online Quizzes

Due date: Throughout the term (weeks 2, 4, 7 and 10)

4 quizzes (worth 5% each) will be given online (Moodle). Questions will range between the direct application of the concepts/calculations given in class, to more critical assessment of topics, documents provided.

Assessment 2: Mid-Term Quiz

Due date: 14/10/22 by 9pm

The quiz (60 min) is intended primarily as a formative assessment but is counted towards the final mark at a significant level to encourage students to take it seriously and to discourage last-minute cramming. This quiz will be assessed on the basis of technical accuracy of calculations and evidence of good engineering judgment with assumptions and problem simplification. Quiz is closed book.

Assessment 3: Assignment

Due date: 05/11/2021 09:00 PM

The Assignment is a core part of this course. In this assignment project students will have an opportunity to apply concepts learned in class and the basic principles of transport phenomena in membranes.

This assignment is submitted through Turnitin and students can see Turnitin similarity reports.

Assessment 4: Final Exam

Assessment length: 90 min
Due date: Exam period

This quiz is given because the course learning outcomes include a significant level of technical learning that can be effectively assessed in an exam environment and because exams have high reliability. The examination is 90 min and will cover the general principles of membrane technology as described in the course notes, tutorials and seminars. Quiz is closed book.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

Course Schedule

Date	Tuesdays 4.00-6.00pm	Thursdays 2.00-4.00pm	Homework
Week 1	Introduction to membrane processes	Microfiltration- Ultrafiltration	See lecture notes
Week 2	Membrane for wastewater treatment	Membrane Bioreactors (MBR)	See lecture notes **Online quiz 1** **(Membrane basics)**
Week 3	Nanofiltration (NF) – Reverse Osmosis (RO); Part 1	NF-RO; Part 2 Intro to Q+	Self-study questions
Week 4	MBR design Tutorial	Fouling and fouling control Membrane ageing and autopsy	Virtual water plant visits **Online quiz 2** **(Water Plants)**
Week 5	Q+ Tutorial Introduction to assignment	Making of polymeric membrane	**Online mid-term quiz**
Week 6	*Flexible week* Online “Ask Me Anything” Session	*Revisions, and work on assignment and Q+*	**--**
Week 7	Gas Separation (Part 1)	Gas Separation (Part 2)	**Online quiz 3** **(Q+ submission)**
Week 8	Advanced membrane characterisation	Membrane distillation, contactors	MBR design **Assignment due**
Week 9	Bioseparation	Feedback on assignment	**Revisions**
Week 10	Virtual lab visit **Online quiz 4 (Lab visit)**	Research showcase	**Peer-review of assignments due**

Resources

Recommended Resources

Course Notes from CEIC8341 and/or the textbooks listed below will be helpful. More notes will be given within the first weeks of session; students are expected to work on the self study questions and their assignment at their own speed. Some of the notes will be available on Moodle.

Key references:

- M. Mulder, *Basic Principles of Membrane Technology*, 2nd Ed., Dordrecht, Kluwer Academic Publishers, (1996)
- R.H. Perry & D.W. Green (Eds.), *Perry's Chemical Engineers' Handbook*, 7th Ed., N.Y., McGrawHill, pp 22-37 – 22-69 (1997)
- W.S.W. Ho & K.K. Sirkar (Eds.), *Membrane Handbook*, N.Y., Van Nostrand Reinhold (1992)

Other resources:

- American Waste Water Association, *Water treatment membrane processes*, McGraw-Hill (1996)
- Z. Amjad, *Reverse Osmosis – Membrane technology, water chemistry and industrial applications*, Van Nostrand Reinhold (1993)
- Metcalf and Eddy, *Wastewater engineering, treatment and reuse*, McGraw-Hill (2002)
- S. Judd, *The MBR book,* Elsevier publishing - 2nd edition (2010)
- S. Judd & B. Jefferson (Eds) *Membranes for Industrial Wastewater Recovery and Re-use*, Elsevier Science Ltd. (2003)
- M. Cheryan, *Ultrafiltration and Microfiltration Handbook*, Technomic (1998)

Millipore, Kutoba, SUEZ (Zenon), Whatman, DuPont and other membrane companies have their catalogues on-line with membrane characteristics and recent applications.

Many membrane-based research journals (Journal of Membrane Science, Desalination, Water Research, Water Sciences and Technologies) and industrial journals (Membrane Technology and Filtration&Separation) could be found on: http://www.sciencedirect.com

Course Evaluation and Development

Course evaluation and development feedback is welcome any time but is primarily sought through the myExperience survey run at the end of term.

Based on previous feedback, we have spent a lot of effort to clarify what you need to do for each assignment (through clearer marking rubrics and work expectations), and give you much more immediate feedback on your progress during the term.

Submission of Assessment Tasks

In the School of Chemical Engineering, all written work will be submitted for assessment via Moodle unless otherwise specified. Attaching cover sheets to uploaded work is generally not required; when you submit work through Moodle for assessment you are agreeing to uphold the Student Code.

Some assessments will require you to complete the work online and it may be difficult for the course coordinator to intervene in the system after the due date. You should ensure that you are familiar with assessment systems well before the due date. If you do this, you will have time to get assistance before the assessment closes.

All submissions are expected to be neat and clearly set out. Your results are the pinnacle of all your hard work and should be treated with due respect. Presenting results clearly gives the marker the best chance of understanding your method; even if the numerical results are incorrect.

Marking guidelines for assignment submissions will be provided at the same time as assignment details to assist with meeting assessable requirements. Submissions will be marked according to the marking guidelines provided.

Late penalties

Unless otherwise specified, submissions received after the due date and time will be penalised at a rate of 5% per day or part thereof (including weekends). For some activities including Moodle quizzes and Team Evaluation surveys, extensions and late submissions are not possible.

Special consideration

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to submitting an assessment or sitting an exam.

UNSW has a Fit to Sit / Submit rule, which means that if you attempt an exam or submit a piece of assessment, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

Note: UNSW does not require a medical certificate for COVID-related absences of 7 days or less, however you must provide formal evidence from your local/state health provider (e.g. NSW Health) that clearly states your name and the date you tested positive (i.e. confirmation of your RAT registration, PCR test result). Longer absences due to extended self-isolation or COVID-related illness will still need documentation such as a medical certificate.

Applications for special consideration **will still be required** for assessment and participation absences related to COVID-19. Special consideration requests should not be lodged for missing classes if there are no assessment activities in that class.

Academic Honesty and Plagiarism

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage (International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013). At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and plagiarism can be located at:

- The Current Students site
- The ELISE training site

The Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism. Further information about referencing styles can be located at https://student.unsw.edu.au/referencing.

For assessments in the School of Chemical Engineering, we recommend the use of referencing software such as Mendeley or EndNote for managing references and citations. Unless required otherwise specified (i.e. in the assignment instructions) students in the School of Chemical Engineering should use either the APA 7th edition, or the American Chemical Society (ACS) referencing style as canonical author-date and numbered styles respectively.

Academic Information

To help you plan your degree, assistance is available from academic advisors in The Nucleus and also in the School of Chemical Engineering.

Additional support for students

- Current Student Gateway
- Engineering Current Student Resources
- Student Support and Success
- Academic Skills
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- IT Service Centre

Course workload

Course workload is calculated using the Units-Of-Credit (UOC). The normal workload expectation for one UOC is approximately 25 hours per term. This includes class contact hours, private study, other learning activities, preparation and time spent on all assessable work.

Most coursework courses at UNSW are 6 UOC and involve an estimated 150 hours to complete, for both regular and intensive terms. Each course includes a prescribed number of hours per week (h/w) of scheduled face-to-face and/or online contact. Any additional time beyond the prescribed contact hours should be spent in making sure that you understand the lecture material, completing the set assignments, further reading, and revising for any examinations.

On-campus class attendance

Physical distancing recommendations must be followed for all face-to-face classes. To ensure this, only students enrolled in those classes will be allowed in the room. Class rosters will be attached to corresponding rooms and circulated among lab demonstrators and tutors. No over-enrolment is allowed in face-to-face class. Students enrolled in online classes can swap their enrolment from online to a **limited** number of on-campus classes by Sunday, Week 1.

In certain classroom and laboratory situations where physical distancing cannot be maintained or the staff running the session believe that it will not be maintained, face masks will be designated by the course coordinator as **mandatory PPE** for students and staff. Students are required to bring and use their own face mask. Mask can be purchased from IGA Supermarket (Map B8, Lower Campus), campus pharmacy (Map F14, Middle Campus), the post office (Map F22, Upper Campus) and a vending machine in the foyer of the Biological Sciences Building (Map E26, Upper Campus).

Your health and the health of those in your class is critically important. You must stay at home if you are sick or have been advised to self-isolate by NSW health or government authorities. Current alerts and advice can be found here. Do not come to campus if you have any of the following symptoms: fever (37.5 °C or higher), cough, sore throat, shortness of breath (difficulty breathing), runny nose, loss of taste, or loss of smell. If you need to have a COVID-19 test, you must not come to campus and remain in self-isolation until you receive the results of your test.

You will not be penalised for missing a face-to-face activity due to illness or a requirement to self-

isolate. We will work with you to ensure continuity of learning during your isolation and have plans in place for you to catch up on any content or learning activities you may miss. Where this might not be possible, an application for fee remission may be discussed. Further information is available on any course Moodle or Teams site.
For more information, please refer to the FAQs: https://www.covid-19.unsw.edu.au/safe-return-campus-faqs

Note: This course outline sets out description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle should be consulted for the up to date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline (as updated in Moodle), the description in the Course Outline/Moodle applies.

Image Credit

Dr Peter Wich

CRICOS

CRICOS Provider Code: 00098G

Acknowledgement of Country

We acknowledge the Bedegal people who are the traditional custodians of the lands on which UNSW Kensington campus is located.

Appendix: Engineers Australia (EA) Professional Engineer Competency Standard

Program Intended Learning Outcomes	
Knowledge and skill base	
PE1.1 Comprehensive, theory based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline	✓
PE1.2 Conceptual understanding of the mathematics, numerical analysis, statistics, and computer and information sciences which underpin the engineering discipline	
PE1.3 In-depth understanding of specialist bodies of knowledge within the engineering discipline	✓
PE1.4 Discernment of knowledge development and research directions within the engineering discipline	
PE1.5 Knowledge of engineering design practice and contextual factors impacting the engineering discipline	
PE1.6 Understanding of the scope, principles, norms, accountabilities and bounds of sustainable engineering practice in the specific discipline	
Engineering application ability	
PE2.1 Application of established engineering methods to complex engineering problem solving	✓
PE2.2 Fluent application of engineering techniques, tools and resources	✓
PE2.3 Application of systematic engineering synthesis and design processes	
PE2.4 Application of systematic approaches to the conduct and management of engineering projects	
Professional and personal attributes	
PE3.1 Ethical conduct and professional accountability	
PE3.2 Effective oral and written communication in professional and lay domains	
PE3.3 Creative, innovative and pro-active demeanour	
PE3.4 Professional use and management of information	
PE3.5 Orderly management of self, and professional conduct	
PE3.6 Effective team membership and team leadership	